

## **Bur Oak Savanna**

### **1992**

Bur oak savanna remnants exist in the southern half of WNT. Native herbaceous vegetation typical of savanna exists in the understory and will serve as a fuel base for future prescribed burns.

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### **1993**

Much interest has been generated in savannas as a topic. In February 1993, the first North American Oak Savanna Conference was held in Chicago, Illinois. Refuge Biologist Drobney was a participant in an effort to share information and to draft a Midwest Savanna Ecosystem Recovery Plan.

During the same conference, interest was generated in WNT's savannas that have mesic to wet-mesic characteristics. Most of the current information about savannas has been derived from sand savannas. Sand savannas have been more likely to survive because they are less suited to agriculture and therefore less a subject to the plow. In addition, invasive woody species often tend to develop more slowly in dry sandy areas resulting in a longer time period prior to canopy closure.

In some areas on WNT, prairie cord grass and other moisture loving species occur in the oak understory on hillsides associated with seeps. In other areas, savannas occur in relatively low moist areas. WNT, therefore, is potentially an important study site that could yield a better understanding of a once common kind of Midwestern oak savanna that is poorly understood and largely obliterated.

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### **1998**

In 1998, we cleared approximately 3 acres of trees in natural community remnants including Thorn Valley Savanna, Coneflower Prairie, Buzzard Head, and Don's II.

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### **1999**

Hundreds of orchids of three species including twayblade (*Liparis liliifolia*), showy orchis (*Galearis spectabilis*), and nodding ladies' tresses (*Spiranthes cernua*) were manifest and blooming profusely in summer of 1999 in the Buzzard Head Prairie remnant. A special project of one of the Prairie Builder Interns was to evaluate numbers of orchids and make management recommendations. As a result of this study and efforts

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by the Friends Prairie volunteers, orchid populations were found to be far more extensive than originally believed. The twayblade and showy orchis are primarily species of woody communities and the nodding ladies' tresses of prairie communities. Several young oaks and a number of characteristic prairie species in this area indicate that the area would most appropriately be managed as a savanna remnant.

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### 2000

A spring burn of the Thorn Valley savanna has resulted in a shift to tall, early successional, native species such as Jerusalem artichoke (*Helianthus tuberosa*) mixed with annuals, replacing the brome. Sedges are becoming a more apparent portion of the flora. Weedy woody species such as multi-flora rose (*Rosa multiflora*) and raspberries (*Rubus occidentalis*) that once were very abundant are still present, though smaller in stature and apparently less dense.

**Friends of the Prairie Learning Center** - The Friends continue to be a breath of fresh air for the refuge. They supported and/or completed a number of projects for the refuge and for themselves. The following is a list of highlights from the Friends' annual report:

Continued Stewardship Saturday. The Friends support the refuge every second Saturday of each month by volunteering a day for land stewardship. They have "adopted" a section of the refuge by the Tallgrass Trail where they are removing trees from a degraded savanna.

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### 2002

Restoring native savanna ecosystems in the prairie-forest transition zone of Iowa. - (*Principle Investigator: Dr. Heidi Asbjornsen. Abstract of proposal accepted by Neal Smith NWR*) - Savanna ecosystems once comprised a dominant feature of the vegetation mosaic in the North-Central region of the United States prior to their destruction by deforestation and agricultural conversion. With the loss of these ecosystems, many native plant and wildlife species are now endangered, and invasion by exotic species such as garlic mustard, buckthorn, and honeysuckle are escalating. Further, important regulatory functions performed by savanna ecosystems related to the cycling of water, nutrients and energy have also diminished, as reflected by increased nutrient and sediment loading of surface waters, declining soil productivity and growing frequency of drought and flooding. These changes directly threaten the ecological and economic sustainability of Iowa's agroecosystems. Efforts to reestablish the oaks, grasses and forbs that once comprised the native savanna ecosystems are showing tremendous promise for ameliorating these environmental problems by restoring important ecological functions and enhancing biodiversity. However, our understanding of the effects of different restoration techniques and models on current vegetation communities and their

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effectiveness in achieving restoration objectives for savanna ecosystems is poor. We propose to establish an integrated management and research program for restoring native savanna/woodland vegetation communities to the landscape mosaic in the north-central U.S., focusing on the Neal Smith Wildlife Refuge and several additional high-priority sites in Iowa for this pilot project. To conduct this research, we have assembled a well-qualified team of researchers from various disciplines (hydrology, forest ecology, animal ecology, soil science) and collaborating institutions (University of Iowa, Iowa State University, Soil Tilth Lab). The implementation of the integrated management and research activities proposed for this project will result in the creation of model restoration systems that demonstrate techniques for significantly improving in the quality of the soil, water, and vegetation that underpin the ecological productivity on which communities in Iowa depend upon for their sustainability.

Methods: Referring to the Bur Oak Savanna Ecosystem Project (*Ashbjornse*)

### Experimental treatments:

At each plot on selected study sites, approximately half will receive restoration treatments, while the other half will remain untreated as a control. Initial treatment will consist of manual removal of all understory trees and shrubs not considered part of the native savanna. The leaves of the cut material (which contain most of the plant nutrients) will be allowed to dry and fall to the ground to decompose naturally on site, while the woody material will be piled outside the site and burned.

The restoration treatment site will be burned periodically (every 2-3 years) during the first 10 years until a healthy understory of herbaceous plants has established.

On sites where the canopy overstory does not currently contain an adequate population of savanna woody species and where seedlings of these species are not regenerating naturally in the understory, seedlings will be produced in a tree nursery using seed collected from trees growing near the site and transplanted to the site.

### Ecological measurements:

**Vegetation:** Plant species composition and diversity will be monitored prior to the treatments and annually following the treatments to determine changes in the plant community over time due to restoration treatments.

**Productivity and carbon sequestration:** Biomass of the overstory trees will be assessed over time based on height and diameter measurements. Biomass of the understory herbaceous vegetation will be assessed by harvesting sub-samples from 1m<sup>2</sup> quadrants. Leaf area will be determined using hemispherical photography. Changes in belowground biomass and

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productivity will be estimated using sequential root coring techniques. Combined, the above measurements will be used to estimate productivity and the contribution of the vegetation communities to carbon cycling.

Water cycling and plant-soil interactions: Soil moisture at different depths (Time Domain Reflectometry-TDR) and evapotranspiration will be monitored periodically to determine changes in water cycling due to restoration processes. Physiological responses of the dominant plant species to changes in site moisture conditions will be assessed using pre-dawn moisture potential measurements and by monitoring changes in plant growth and leaf area.

Fieldwork implemented in 2002:

Permanent transects were established at one of the three proposed savanna restoration sites (Bird Head). The site was divided length-wise (north-south) into two sections of similar size, and a single north-south transect established in the center of each section (approximately 170 m long). The following data were collected during the summer of 2002:

Soils:

Gypsum blocks were installed along each transects (3 sampling points per transect) at 4 different depths per sampling point (10, 30, 60, and 100 cm). Moisture readings were obtained weekly with assistance from the Refuge staff.

Vegetation:

Overstory trees (dbh > 2.5 cm) – height, dbh, species; 2 m on either side of the transect.

Saplings (dbh < 2.5 cm, height > 1 m) – height, dbh, species; 1 m on either side of the transect.

Seedlings and shrubs (height < 1 m and > 30 cm) – species, basal diameter; 10 m intervals, 3 m radius

Seedlings and herbaceous plants (height < 30 cm) – species and basal diameter (seedlings); percent cover (grasses and herbs); 10 m intervals, 1 m quadrant

Canopy cover (hemispherical photography); 10 m intervals.

**Dr. Heidi Asbjornsen, Iowa State University, Ames, Iowa (collaborators listed at end) - Research Topic: Oak Savanna Research at Neal Smith Wildlife Refuge** - Oak savanna is considered one of the most rare and poorly understood ecosystems in the United States. Once covering approximately 11-13 million hectares in the tall grass prairie ecoregion of the Midwest, only about 0.02% of the original extent of oak savanna ecosystems remain on the landscape today. Characterized by widely scattered open-

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grown oak trees and a continuous understory of native grasses and forbs, these systems were maintained in the landscape by complex interactions between fire, climate, topography, grazing, and human activities. Due to fire suppression and overgrazing, the few remnants that are left today usually exist in a highly degraded state, and require active restoration in order to reestablish elements of the former savanna species composition, structure and ecosystem health. However, savanna restoration is a relatively recent management activity, having been performed primarily on an *ad hoc* basis during the past 10-15 years, using empirical or anecdotal information to guide the restorations. Therefore our knowledge about restoration techniques and ecosystem responses is much more limited compared to prairie restoration.

Research on savanna restoration was initiated at the Neal Smith NWR in 2003 as a collaborative project with Iowa State University. The study includes two remnant savanna sites (approximately 15-20 acres each) that are characterized by large, open-grown white oak and burr oak trees (indicative of former savanna habitat), which as a result of fire suppression have become overgrown with shade tolerant tree species (e.g., ironwood, elm, ash, dogwood). Restoration treatments will be applied to a portion of these sites this winter (2003-4), and will involve mechanical removal of the non-savanna tree species, followed by annual or semi-annual prescribed burning, beginning in the spring or fall of 2004. The primary objective of the research is to understand the changes in plant species composition and ecological functioning in response to the restoration treatments. In particular, we are interested in understanding how interactions between the trees and the understory herbaceous vegetation in restored and degraded savanna ecosystems regulate the cycling of water and nutrients through the system. The results of this research will help inform future restoration work, both at the refuge and at other sites in the Midwest.

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### 2003

As a tallgrass prairie restoration site, our focus is on restoring prairie, not on forest management. However, we are currently trying to restore a 40 acre oak savanna site to its native appearance, this would be our forest management. We have been removing unwanted trees such as black locust, ash, elm, and maple to open up the canopy so light will reach the ground.

Throughout the spring, summer and early fall, crews of volunteers and staff worked to clear trees and brush from the savanna. Small trees were clipped and cut using loppers and bow saws, while larger trees were cut using chainsaws. All of the brush was removed and piled outside of the savanna to be burned at a later date. All of the stumps were treated with Garlon 3A to prevent the sprouting and re-growth of the trees that were removed. The SCA and range tech crews spent a great deal of time removing and treating black locust trees from the area.

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The refuge currently maintains a nature trail that winds its way through the oak savanna. This allows visitors to monitor our progress in the restoration process. A burn plan has been established for this unit as well. The burning of the savanna will allow us to knock back some of the undergrowth, stimulate growth of the understory, as well as help to eliminate some of the trees that are not fire tolerant. Our future management plans for this area are to continue to remove invasive species of trees and treat the stumps with chemicals to prevent any regeneration of the tree. Burning of this area will help also help to prevent any regeneration of these trees as well.

**Earth Day** - Murray coordinated Earth Day activities on Saturday, April 19<sup>th</sup>. Murray gave a briefing and divided the crews up among several different areas. Crews worked on the prairie production plots, the savanna restoration project for tree cutting and brush removal, and Shea directed some local Boy Scout troops to specified trash pickup zones along the main road.

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### 2004

#### **Oak savanna research at Neal Smith National Wildlife Refuge: Hydrologic Response of Degraded Oak Savannas to Restoration Treatments** - Principal

Investigator: Heidi - Asbjornsen, Iowa State University - **Brief background:** Research on savanna restoration was initiated at the Neal Smith National Wildlife Refuge in 2003 as a collaborative project with Iowa State University (see Research Summary submitted in 2003 for more detailed background information). The study includes two remnant savanna sites (approximately 15-20 ha each; “Birdhead” and “Old Game Farm”) that are characterized by large, open-grown white oak and burr oak trees (indicative of former savanna habitat), which as a result of fire suppression have become overgrown with shade tolerant tree species (e.g., ironwood, elm, ash, dogwood). The primary objective of the research is to understand the changes in plant species composition and ecological functioning in response to the restoration treatments. In particular, we are interested in understanding how interactions between the trees and the understory herbaceous vegetation in restored and degraded savanna ecosystems regulate the cycling of water and nutrients through the system. The results of this research will help inform future restoration work, both at the Refuge and at other sites in the Midwest.

**Restoration treatments:** Mechanical removal of all non-savanna tree species (i.e., everything except for white and bur oak) was conducted in the treatment area at “Old Game Farm” during the winter of 2003-4. Burning was scheduled to occur during the fall of 2004, but was postponed due to inadequate fuel availability.

**Plant species composition:** Plant species in the herbaceous layer were recorded within the treatment and control areas three times during the growing season (April, July, and September). Shrubs were sampled once during the growing season (July).

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**Hydrology:** One groundwater well with a transducer was installed in the treatment and in the control site. Soil moisture access tubes were installed at four points surrounding six large oak trees (3/treatment) and every 20 m along the two main transects (displaced by 2 m from the center line). Soil moisture monitoring was initiated in August-September but then terminated in October due to a failure in the neutron probe equipment.

**Plant water cycling:** Plant transpiration was measured for dominant species in the understory of both the treated and control sites, as well as for corn and prairie plants in the adjacent crop field and reconstructed prairie, respectively. Sap flow equipment (thermal dissipation probes) was installed in six bur oak trees and four subdominant elm trees within the savanna restoration study site, and sap flow monitoring initiated in July.

**Oak regeneration:** To determine the effects of savanna restoration on oak regeneration, naturally occurring bur oak seedlings are monitored at the treatment and control sites savanna sites. In 2003 plots were established in two landscape positions: below bur oak tree canopy and in canopy gaps. This allowed us to determine where seedlings naturally most densely occur, as well as the importance of canopy gaps for their survival and growth. Work in 2004 involved remonitoring all seedlings identified in 2003 for height and basal diameter, as well as adding any newly established seedlings to the study.

**Collaboration:** Research collaborators on this project include Drs. Cindy Cambardella and Mark Tomer (USDA National Soil Tilth Lab), Dr. Keith Schilling (Geologic Survey Bureau, Iowa DNR) and Dr. Cathy Mabry (ISU, NREM). Two graduate students (Lars Brudvig, Ph.D. candidate, NREM/EEB, and Martin Gomez, Ph.D. candidate, NREM) are currently participating in this research. Two other graduate students also involved in this research completed their degrees in 2004 (Chris Evans, M.Sc., NREM and Holly Karnitz, M.Sc., NREM/EEB). Additionally, we are collaborating with the U.S. Forest Service on a project aimed at assessing ecological indicators used in the USFS Forest Inventory Analysis system.

In February, a contractor cut trees in Thorn Valley Savanna to further savanna restoration. Staff followed behind chemically treating stumps to prevent regrowth. Excellent progress was made and a wide area was successfully cleared freeing up oaks to sunlight and promoting regeneration of young oaks as well as savanna ground cover. Volunteers worked steadily to remove the trees and brush from the savanna and form brush piles to be burned in winter. Some of the wood was made available to the public through a special collection permit.

Maintenance Mechanic Boot used the hydra-axe during FY04 on approximately 25 acres of trees. Van Zee used a tree shredder to cut four to five acres of trees encroaching into the prairie restorations (photo 30).

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## 2005

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June 2005

At the request of the Refuge, Linda Haugen (US Forest Service), and Aaron Flickenger (Iowa DNR) evaluated the condition of refuge oaks showing signs of leaf browning, leaf drop, and other stresses. Cause of oak mortality in one tree in the Old Game Farm savanna site was also discussed. Samples were taken from the refuge and from an oak across the road from the refuge that seemed to be seriously declining. Samples were sent to the ISU plant pathology lab.

July 2005

On July 21<sup>st</sup> through July 26<sup>th</sup>, Murray coordinated the activities of 1,380 Calvinist Cadets, who were participating in an international Camporee. Neal Smith National Wildlife Refuge hosted daily group stewardship/service projects for the cadets. Each day saw four groups of 70 scouts rotating through the project site. Each group was greeted and given a safety briefing. They were also given an overview of refuge objectives regarding savanna restoration. The groups then constructed brush piles and cleaned the area. More than 3.5 acres of refuge land was cleared. Many scouts expressed a very positive reaction to the experience. Even with all of the intense and arduous physical activity taking place, no serious injuries were reported.

December 2005

Dave Novak donated yet another day of savanna restoration work on the buzzardhead site Dec 29<sup>th</sup>.

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## **2006**

October 2006

The refuge also hosted 150 volunteers who participated in J.N."Ding" Darling Day activities. This special event is one of two prairie rescue days sponsored annually by the refuge. The focus of the event is stewardship activities. Volunteers come from a number of sources including scouts, churches and civic groups. Staff members coordinate the activities of the volunteers on a number of sites throughout the refuge. This event saw work along the trail system, continued work at the Buzzardhead, Savanna Restoration site, and trash removal along refuge roadways.

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